22096008

International Baccalaureate®
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BIOLOGY
HIGHER LEVEL
PAPER 2

Wednesday 6 May 2009 (afternoon)

2 hours 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer two questions from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

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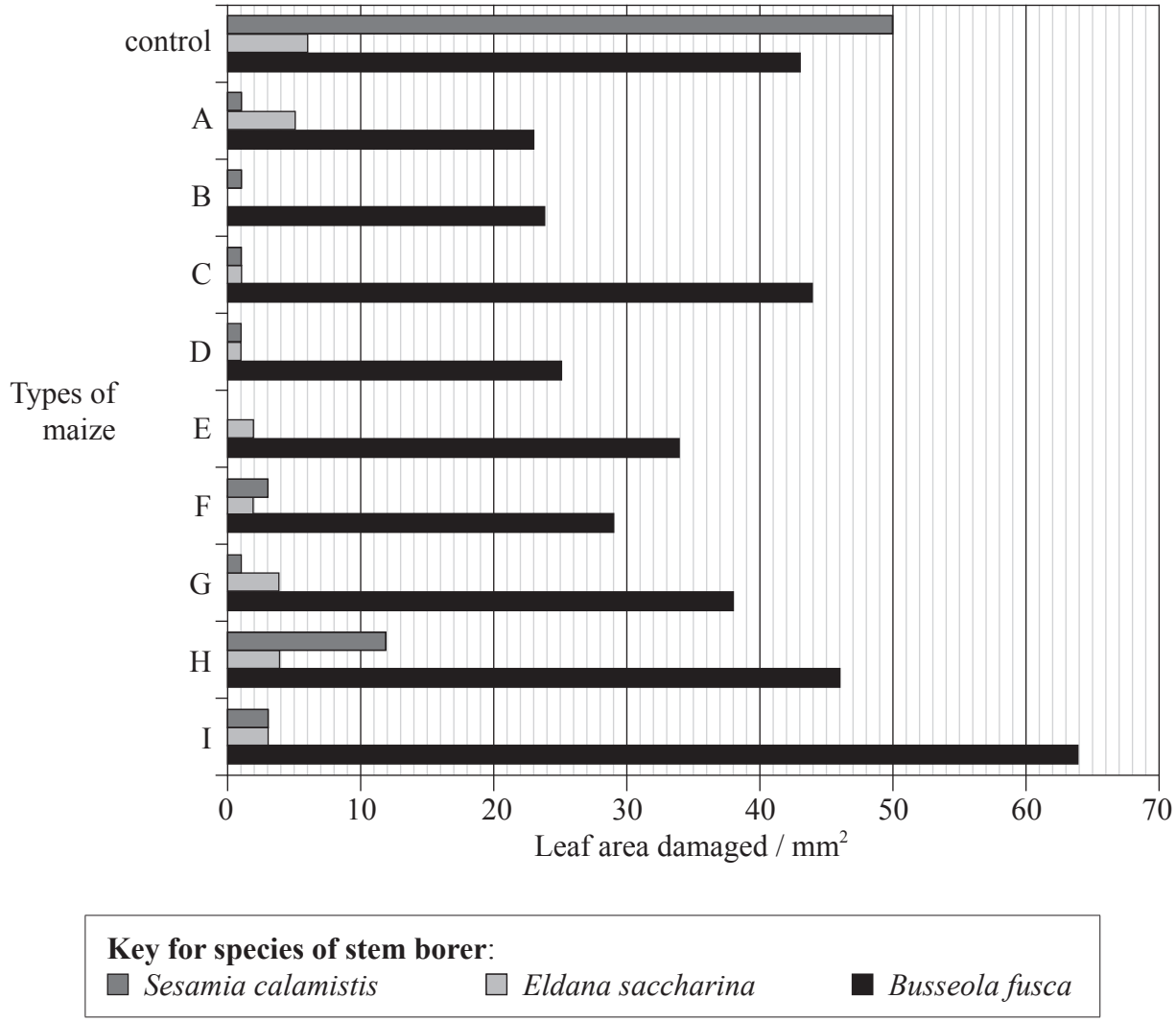
SECTION A

*Answer **all** the questions in the spaces provided.*

1. Genetic engineering allows genes for resistance to pest organisms to be inserted into various crop plants. Bacteria such as *Bacillus thuringiensis* (Bt) produce proteins that are highly toxic to specific pests.

Stem borers are insects that cause damage to maize crops. In Kenya, a study was carried out to see which types of Bt genes and their protein products would be most efficient against three species of stem borer. The stem borers were allowed to feed on nine types of maize (A–I), modified with Bt genes. The graph below shows the leaf areas damaged by the stem borers after feeding on maize leaves for five days.



[Source: S Mugo et al., Figure 3 from "Developing Bt maize for resource-poor farmers—Recent advances in the IRMA project", *African Journal of Biotechnology* (2005), volume 4, number 13, pp. 1490-1504]

(This question continues on the following page)

(Question 1 continued)

(a) Calculate the percentage difference in leaf area damaged by *Sesamia calamistis* between the control and maize type H. Show your working. *[2]*

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(b) Discuss which species of stem borer was most successfully controlled by the genetic engineering of the maize plants. *[3]*

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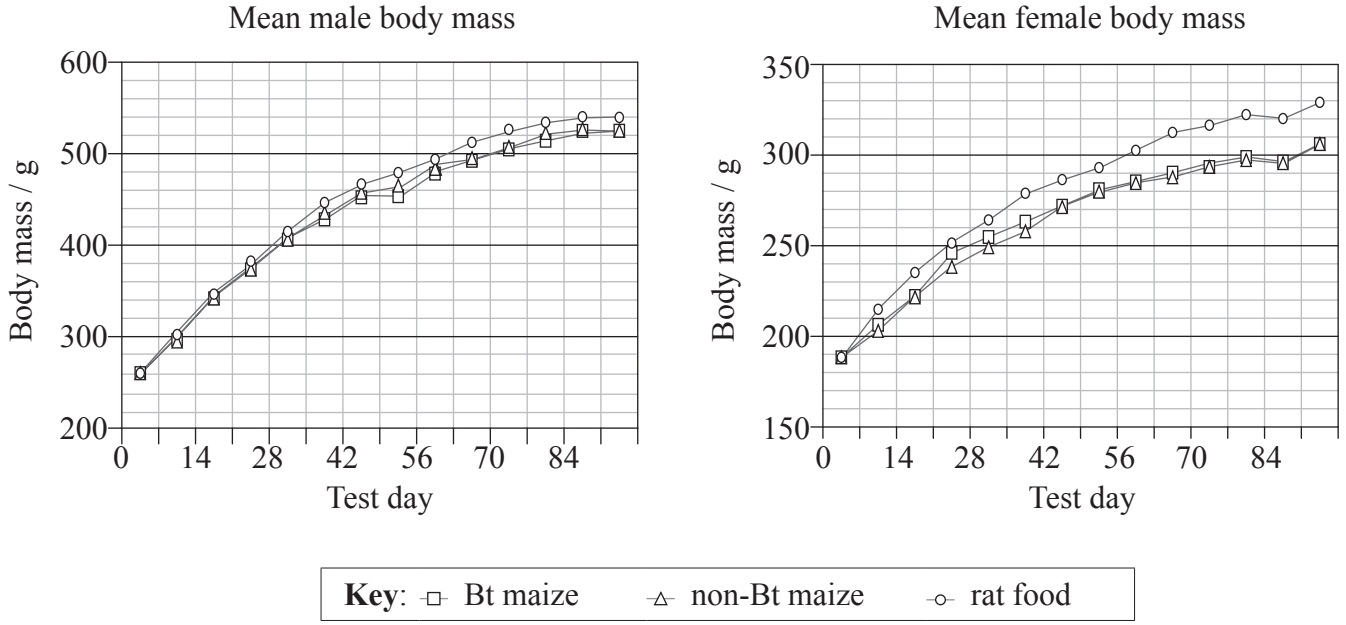
(Question 1 continued)

Before the use of genetically modified maize as a food source, risk assessment must be carried out. A 90-day study was carried out in which adult male and female rats were fed either:

- seeds from a Bt maize variety
- seeds from the original non-Bt maize variety
- commercially prepared rat food.

All the diets had similar nutritional qualities.



[Source: Reprinted from Linda A. Malley _et al_., "Subchronic feeding study of DAS-59122-7 maize grain in Sprague-Dawley rats", _Food and Chemical Toxicology_, volume 45, issue 7, pp. 1277-1292., Copyright (2007), with permission from Elsevier]

(c) Calculate the change in mean mass of male and of female rats fed on Bt maize from day 14 to 42. *[2]*

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(d) Evaluate the use of Bt maize as a food source on the growth of the rats. *[2]*

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(e) Comment on the use of Bt maize as a food source compared to the other diets tested. *[1]*

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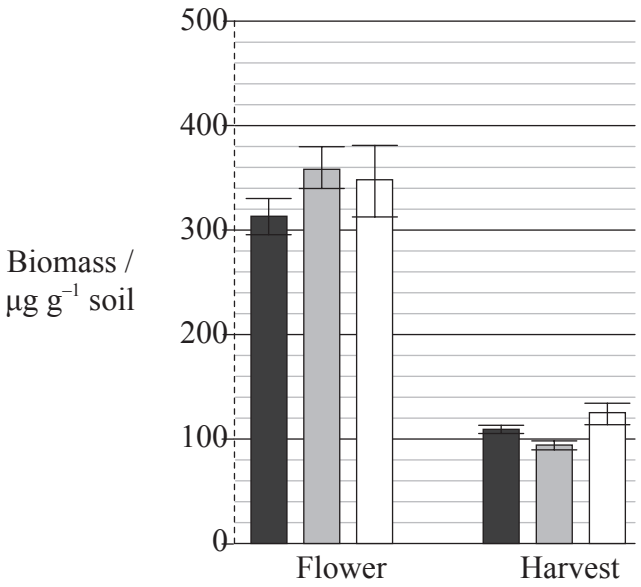
(Question 1 continued)

Studies have shown that Bt proteins are released by plant roots and remain in the soil. One study looked at the biomass of microorganisms in soil surrounding the roots of:

- Bt maize
- non-Bt maize
- non-Bt maize with an insecticide (I).

The graph below shows the biomass of microorganisms at two different times in the growth cycle of the plants (Flower and Harvest). Error bars represent standard error of the mean.



Key: ■ Bt maize ▒ non-Bt maize □ non-Bt maize + I

[Source: Reprinted from M. Devare et al., "Neither transgenic Bt maize (MON863) nor tefluthrin insecticide adversely affect soil microbial activity or biomass: A 3-year field analysis", *Soil Biology and Biochemistry*, Volume 39, Issue 6, pp. 2038-2047, © (2007) with permission from Elsevier]

(f) State **one** role of bacteria in a soil ecosystem. *[1]*

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(g) Compare the biomass of microbes in the soils surrounding the roots of Bt maize and non-Bt maize. *[2]*

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(Question 1 continued)

(h) The researchers' original hypothesis stated that microorganisms would be negatively affected by the Bt protein released by the plant roots. Discuss whether the data supports the hypothesis. *[2]*

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Bt proteins act as toxins to insects, primarily by destroying epithelial cells in the insect's digestive system. Below is the three-dimensional structure of one such protein.

[Source: Reprinted from Mario Soberón, "Mode of action of mosquitocidal Bacillus thuringiensis toxins", *Toxicon*, Volume 49, Issue 5, pp. 597-600 , © (2007) with permission from Elsevier]

(i) (i) State the type of structure shown in the region marked A in the diagram above. *[1]*

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(ii) Outline how this structure is held together. *[2]*

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(iii) Region A inserts into the membrane. Deduce, with a reason, the nature of the amino acids that would be expected to be found in this region. *[2]*

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2. (a) In some maize plants the seed is enclosed in a green sheath called a tunica. The allele (T) for this is dominant to the allele (t) for normal, unenclosed seeds. The endosperm of the seed can be starchy (allele E) or sugary (allele e). The genes for these two characteristics are linked. The table below shows the outcome of crosses between a plant heterozygous for both characteristics and one that is homozygous recessive for both characteristics.

Phenotype	Number
Tunica present, starchy	326
Unenclosed seeds, starchy	111
Tunica present, sugary	118
Unenclosed seeds, sugary	295

(i) State the genotype of the heterozygous parent using the correct notation. *[1]*

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(ii) Identify which individuals are recombinants in this cross. *[1]*

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(iii) Explain what has occurred to cause these results. *[2]*

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(b) Maize belongs to the group of plants known as angiospermophyta. Distinguish between angiospermophytes and bryophytes. *[2]*

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3. (a) The electron micrograph below shows a section of a liver cell.

IMAGE REMOVED FOR COPYRIGHT REASONS

(i) Identify the structure labelled I and state **one** function of this structure. *[1]*

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(ii) Calculate the magnification of this photograph. Show your working. *[1]*

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(This question continues on the following page)

(Question 3 continued)

(iii) Explain the evidence from the electron micrograph that indicates that liver cells are very active. *[2]*

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(b) Compare the relative sizes of viruses and bacteria to this cell. *[2]*

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SECTION B

*Answer **two** questions. Up to two additional marks are available for the construction of your answers. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

4. (a) Draw a labelled diagram of the structure of a chloroplast as seen with an electron microscope. *[4]*

(b) Describe how water is carried by the transpiration stream. *[7]*

(c) Explain how flowering is controlled in long-day and short-day plants. *[7]*

5. (a) Outline a possible cause of Down syndrome. *[4]*

(b) Outline the processes involved in oogenesis within the human ovary. *[8]*

(c) Discuss the ethical issues surrounding IVF. *[6]*

6. (a) Distinguish between RNA and DNA. *[3]*

(b) Explain the process of DNA replication. *[8]*

(c) Outline how enzymes catalyse reactions. *[7]*

7. (a) Outline how antibiotic resistance in bacteria can arise in response to environmental change. *[5]*

(b) Outline the principle of immunity. *[6]*

(c) Discuss the benefits and dangers of vaccination. *[7]*